

Osteoporosis

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Introduction

Osteoporosis is a disease of the skeleton characterized by a weakened structure due to decreased bone mass. A major consequence of the disease is the increased risk of fracture. Osteoporosis occurs either when the body reabsorbs too much bone, does not replace enough bone, or a combination of both. Some of the risk factors for osteoporosis include age over 50, family history, and lack of sex hormones (more often in post-menopausal women). Osteoporosis is only a medical problem once a fracture occurs. Early diagnosis normally occurs through bone mineral density screening (i.e., Dual-Energy X-ray Absorptiometry (DEXA) or Computed Tomography (CT) scans, or ultrasound) prior to the occurrence of a bone fracture as part of preventive medicine screening. Treatment of bone density diagnosed pre-osteoporosis (osteopenia) or osteoporosis may include modalities such as increased exercise, dietary changes including adequate intake of calcium and vitamin D, and prescription medications.

Clinical Priority and Clinical Priority Rationale by Design Reference Mission

One of the inherent properties of space flight is a limitation in available mass, power, and volume within the space craft. These limitations mandate prioritization of what medical equipment and consumables are manifested for the flight, and which medical conditions would be addressed. Therefore, clinical priorities have been assigned to describe which medical conditions will be allocated resources for diagnosis and treatment. “Shall” conditions are those for which diagnostic and treatment capability must be provided, due to a high likelihood of their occurrence and severe consequence if the condition were to occur and no treatment was available. “Should” conditions are those for which diagnostic and treatment capability should be provided if mass/power/volume limitations allow. Conditions were designated as “Not Addressed” if no specific diagnostic and/or treatment capability are expected to be manifested, either due to a very low likelihood of occurrence or other limitations (for example, in medical training, hardware, or consumables) that would preclude treatment. Design Reference Missions (DRMs) are proposed future missions designated by a set of assumptions that encompass parameters such as destination, length of mission, number of crewmembers, number of Extravehicular Activities (EVAs), and anticipated level of

care. The clinical priorities for all medical conditions on the Exploration Medical Condition List (EMCL) can be found here (https://humanresearchwiki.jsc.nasa.gov/index.php?title=Category:All_DRM). The EMCL document may be accessed here (https://humanresearchwiki.jsc.nasa.gov/images/6/62/EMCL_RevC_2013.pdf).

Design Reference Mission	Clinical Priority	Clinical Priority Rationale
<p>Lunar sortie mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 4 crewmembers (3 males, 1 female) 14 days total 4 EVAs/crewmember <u>Level of Care 3</u> 	Not Addressed	Given the short Lunar sortie mission duration, bone loss is unlikely to impact mission objectives.
<p>Lunar outpost mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 4 crewmembers (3 males, 1 female) 180 days total 90 EVAs/crewmember <u>Level of Care 4</u> 	Shall	Microgravity-related bone loss is one of the adverse effects of long-duration space flight that is not yet adequately mitigated with current countermeasures. In-flight testing would be useful for exploration-class missions to gauge the severity of bone loss and to titrate exercise prescriptions and initiate pharmacological treatment as needed.
<p>Near-Earth Asteroid (NEA) mission</p> <p>Assumptions:</p> <ul style="list-style-type: none"> 3 crewmembers (2 males, 1 female) 395 days total 30 EVAs/crewmember <u>Level of Care 5</u> 	Shall	Microgravity-related bone loss is one of the adverse effects of long-duration space flight that is not yet adequately mitigated with current countermeasures. In-flight testing would be useful for exploration-class missions to gauge the severity of bone loss and to titrate exercise prescriptions and initiate pharmacological treatment as needed.

Initial Treatment Steps During Space Flight

A link is provided to a prior version of the International Space Station (ISS) Medical Checklist, which outlines the initial diagnostic and treatment steps recommended during space flight for various conditions which may be encountered onboard the ISS. Further diagnostic and treatment procedures beyond the initial steps outlined in the Medical Checklist are then recommended by the ground-based Flight Surgeon, depending on the clinical scenario.

Please note that this version does not represent current diagnostic or treatment capabilities available on the ISS. While more recent versions of this document are not accessible to the general public, the provided version of the checklist can still provide a general sense of how medical conditions are handled in the space flight environment. Medical Checklists will be developed for exploration missions at a later point in time.

Please note this file is over 20 megabytes (MB) in size, and may take a few minutes to fully download.

ISS Medical Checklist (http://www.nasa.gov/centers/johnson/pdf/163533main_ISS_Med_CL.pdf)

Capabilities Needed for Diagnosis

The following is a hypothetical list of capabilities that would be helpful in diagnosis. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Quantification of bone density [such as with a Dual-Energy X-ray Absorptiometry (DEXA) scan, quantitative Computed Tomography (CT), quantitative Ultrasound, other]
- Clinical laboratory (monitoring bone degradation markers, hormones, etc.)
- Muscle strength monitoring capability

Capabilities Needed for Treatment

The following is a hypothetical list of capabilities that would be helpful in treatment. It does not necessarily represent the current capabilities available onboard current spacecraft or on the ISS, and may include capabilities that are not yet feasible in the space flight environment.

- Pharmacy (e.g. bisphosphonates or an inhibitor of RANK Ligand)
- Exercise
- Artificial gravity

Associated Gap Reports

The NASA Human Research Program (HRP) identifies gaps in knowledge about the health risks associated with human space travel and the ability to mitigate such risks. The overall objective is to identify gaps critical to human space missions and close them through research and development. The gap reports that are applicable to this medical condition are listed below. A link to all of the HRP gaps can be found here (<http://humanresearchroadmap.nasa.gov/Gaps/>).

- 1.01 - We do not know which emerging technologies are suitable for preflight medical screening for exploration missions.
- 2.01 - We do not know the quantified health and mission outcomes due to medical events during exploration missions.
- 3.03 - We do not know which emerging technologies are suitable for in-flight screening, diagnosis, and treatment during exploration missions.
- 4.01 - We do not have the capability to provide a guided medical procedure system that integrates with the medical system during exploration missions.
- 4.02 - We do not have the capability to provide non-invasive medical imaging during exploration missions.
- 4.05 - We do not have the capability to measure laboratory analytes in a minimally invasive manner during exploration missions.
- 4.14 - We do not have the capability to track medical inventory in a manner that integrates securely with the medical system during exploration missions.
- 4.15 - Lack of medication usage tracking system that includes automatic time stamping and crew identification
- 4.17 - We do not have the capability to package medications to preserve stability and shelf-life during exploration missions.
- 4.24 - Lack of knowledge regarding the treatment of conditions on the Space Medicine Exploration Medical Condition List in remote, resource poor environments (Closed)
- 5.01 - We do not have the capability to comprehensively manage medical data during exploration missions.

Other Pertinent Documents

List of Acronyms

C	
CT	Computed Tomography
D	
DEXA	Dual-Energy X-ray Absorptiometry
DRM	Design Reference Mission
E	
EMCL	Exploration Medical Condition List
EVA	Extravehicular Activity
H	
HRP	Human Research Program
I	
ISS	International Space Station
M	
MB	Megabyte
MRI	Magnetic Resonance Imaging
N	
NASA	National Aeronautics and Space Administration
NEA	Near Earth Asteroid

R	
RANK	Receptor Activator of Nuclear Factor κ B
X	
X-ray	Radiograph

References

Last Update

This topic was last updated on 8/12/2014 (Version 2).

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Category: Medical Conditions

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